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# GRASSHOPPER RESEARCH 1951 and 1952

Bozeman, Montana and Tempe, Arizona

Field Stations.

Bureau of Entomology and Plant Quarantine.

(Not for publication)

# Spray Tests 1950, 1951, and 1952

## Aldrin

Aldrin was tested on alfalfa in Arizona and on range in Montana in 1950 and 1951. The following results are average 3-day mortalities over the 2-year period.

| Rate per Acre Ounces | No. Trials | Percent Kill |
|---|---|---|
| 0.5 | 15 (Turbine blower) | 74 |
| 1 | 73 | 79 |
| 1½ | 8 (airplane) | 85 |
| 2 | 102 | 87 |
| 3 | 9 (Turbine blower) | 97 |

Comparisons between 1 and 2 ounces in green, drying, and dry alfalfa gave the following average results.

| Rate per Acre Ounces | Condition of Alfalfa | Formulation | No. Trials | Percent kill |
|---|---|---|---|---|
| 1 | green | Emulsion | 17 | 88 |
| 2 | green | " | 17 | 91 |
| 1 | drying | " | 14 | 89 |
| 2 | drying | " | 14 | 93 |
| 1 | dry | " | 13 | 64 |
| 2 | dry | " | 13 | 72 |
| 2 | dry | Solution | 12 | 96 |

Average kills from acre-dosages of 1 and 2 ounces applied as emulsions and solutions are listed below:

| Rate per Acre Ounces | Formulation | No. trials | Percent kill |
|---|---|---|---|
| 1 | Emulsion | 55 | 81 |
| 1 | Solution | 10 | 80 |
| 2 | Emulsion | 58 | 85 |
| 2 | Solution | 44 | 90 |

Under extremely dry, hot conditions in Arizona 1 ounce killed only 43 percent in 6 trials. This dosage was not applied in solution in comparable tests. Two ounces in emulsion under these conditions killed 50 percent of the hoppers in 6 trials. In 12 trials in the same series 2 ounces applied in solution killed 96 percent.

## Dieldrin

In 1950 dieldrin was tested on small plots at dosages of 1, 2, and 3 ounces. There was little difference in kill between any of the three and the two higher ones were dropped from the 1951 experiments. The following results are average 3-day mortalities for the 1950 and 1951 tests:

| Rate per Acre Ounces | No. Trials | Percent kill |
|---|---|---|
| 0.5 | 20 | 93 |
| .75 | 43 | 92 |
| 1.0 | 59 | 93 |
| 2.0 | 18 | 97 |
| 3.0 | 7 | 99 |

Comparisons between the various dosages were also possible in green, drying, and dry alfalfa in Arizona.

| Rate per Acre Ounces | Condition of Alfalfa | No. Trials | Percent Kill |
|---|---|---|---|
| 0.5 | green | 3 | 91 |
| .75 | " | 8 | 97 |
| | drying | 7 | 96 |
| | dry | 6 | 65 |
| 1.0 | green | 15 | 95 |
| | drying | 13 | 97 |
| | dry | 11 | 82 |

In range lands in Montana all three dosages gave kills of 95 and 96 percent when applied in solution by turbine-blower and aircraft. Aircraft applications gave slightly higher average kills.

Experimental data from 1950-1951 tests with dieldrin grouped to show comparisons between emulsions and solutions.

| Rate per Acre Ounces | Formulation | No. Trials | Percent Kill |
|---|---|---|---|
| 0.5 | Emulsion | 8 | 91 |
| 0.5 | Solution | 12 | 94 |
| .75 | Emulsion | 21 | 88 |
| .75 | Solution | 22 | 97 |
| 1.0 | Emulsion | 47 | 92 |
| 1.0 | Solution | 12 | 96 |

## Heptachlor

Heptachlor was tested at various dosage levels in 1950, 1951, and 1952 in alfalfa in Arizona and on range land in Montana. The results of these tests are listed below:

| Rates per Acre Ounces | Formulation | No. Trials | 3-day Mortalities Percent |
|---|---|---|---|
| 1 | Emulsion | 28 | 80 |
| 2 | " | 35 | 87 |
| 3 | " | 16 | 97 |
| 4 | Emulsion and solution | 18 | 85 |
| 6 | Emulsion | 13 | 88 |
| 8 | " | 13 | 89 |

From the data presented above the 3-ounce dosage would appear to be the best. It is necessary to break the data down further in order to show the true picture. All trials in alfalfa were applied as emulsion. Range land applications were solution.

| Rate per Acre Ounces | Condition of Alfalfa | No. Trials | Percent Kill |
|---|---|---|---|
| 1 | green | 9 | 90 |
| | drying | 6 | 80 |
| | dry | 5 | 67 |
| 2 | green | 16 | 93 |
| | drying | 6 | 83 |
| | dry | 5 | 81 |
| 3 | green | 16 | 97 |
| 4 | green | 7 | 97 |
| | drying to dry | 6 | 61 |
| 6 | green | 7 | 95 |
| | drying to dry | 6 | 79 |
| 8 | green | 7 | 97 |
| | drying to dry | 6 | 79 |

Four ounces applied by aircraft to range land gave 99 percent kill in 5 trials.

## Compound 1189*

This product was tested in 1950 and 1951 in alfalfa in Arizona and range grass in Montana. All applications were made with turbine blower. The following results are the average kills over the two-year period:

| Rate per Acre Pounds | Formulation | Number of Trials | Average Percent Kill 3-4 day | 5-7 day |
|---|---|---|---|---|
| .5 | Emulsion and solution | 22 | 78 | 81 |
| .75 | " " | 45 | 86 | 91 |
| 1.0 | Emulsion | 22 | 87 | 91 |

Comparisons between dosages in green, drying, and dry alfalfa gave the following results. All trials in alfalfa were applied as emulsions. Range land applications were solutions.

| Rate per Acre Pounds | Condition of Alfalfa | No. Trials | Percent Kill 3-4 day | 5-7 day |
|---|---|---|---|---|
| .5 | green | 15 | 80 | 78 |
| .75 | green | 8 | 88 | 86 |
| | drying | 13 | 78 | 90 |
| | dry | 9 | 93 | 95 |
| 1.0 | drying | 13 | 81 | 92 |
| | dry | 9 | 93 | 93 |

One-half pound in range grass applied as a solution gave 75 percent in 3 days and 88 percent in 5 days in 7 trials. Three-fourths pound gave 87 and 93 percent average kills in 15 trials, under similar conditions.

Compound 1189 stood up well under dry hot conditions in dry alfalfa at dosages of .75 and 1 pound per acre. In most instances the 5 to 7 day kills were higher than those of 3-4 days. This would indicate some promise for longer residual kills.

* Compound 1189 is a product of General Chemical Division of Allied Chemical and Dye Corporation. It has been determined as 2, 3, 3a, 4, 5, 6, 7, 7a, 8, 8-decachloro-3a, 4, 7, 7a-tetrahydro-4, 7-methanoindene-1-one.

## CS 708 (Dilan)*

This product was tested in 1950 and 1951 on alfalfa in Arizona and on range grass in Montana.

The following are the average kills over the 2-year period. All applications were made with the turbine blower.

| Rate per Acre Pounds | Formulation | Number of Trials | Percent Kill 3-4 day | Percent Kill 5-7 day |
|---|---|---|---|---|
| .5 | Emulsion and solution | 15 | 89 | 86 |
| .75 | " " | 49 | 83 | 84 |
| 1.0 | Emulsion | 19 | 83 | 78 |

Comparisons of the various dosages in green, drying, and dry alfalfa give the following results. All applications were in emulsions.

| Rate per Acre Pounds | Condition of Alfalfa | No. Trials | Percent Kill 3-4 day | Percent Kill 5-7 day |
|---|---|---|---|---|
| .5 | green | 8 | 90 | 90 |
| .75 | green | 15 | 93 | 91 |
| | drying | 13 | 70 | 83 |
| | dry | 6 | 81 | 71 |
| 1.0 | drying | 7 | 78 | 81 |

One-half pound applied in solution to range grass gave an average kill of 78 percent in 3 days and 82 percent in 5 days in 7 trials. Three-fourths pound killed 85 and 83 percent in 15 trials under similar conditions. This product did not stand up as well as compound 1189 under hot dry conditions. Neither was there any marked indication of residual action.

## Lindane

Lindane was tested in 1950 and 1951 in Arizona and Montana to determine optimum dosage. The results of these tests are given below. All tests were made with emulsions and applied with the turbine blower.

| Rate per Acre Pounds | No. of Trials | Percent Kill |
|---|---|---|
| 0.4 | 8 | 88 |
| 0.5 | 11 | 83 |
| .75 | 9 | 64 |
| 1.0 | 2 | 90 |

Comparisons of these dosages in green, drying, and dry alfalfa give the following results.

| Rate per Acre Pounds | Conditions of Alfalfa | No. of Trials | Percent Kill |
|---|---|---|---|
| 0.5 | green | 5 | 92 |
| | drying | 6 | 75 |
| .75 | drying | 6 | 57 |
| | dry | 3 | 78 |
| 1.0 | dry | 3 | 90 |

* A product of the Commercial Solvents Corporation.

Four-tenths pound applied to range grass gave 88 percent kill in 8 trials.

## Methoxychlor

This product was tested in 1950 on alfalfa and range grass in emulsion. All applications were made with the turbine blower.

| Rate per Acre Pounds | Condition of Alfalfa | No. of Trials | Percent Kill |
|---|---|---|---|
| 3 | green | 7 | 90 |
| 3 | drying | 6 | 66 |
| 4 | dry | 3 | 75 |

Three pounds in range grass gave 91 percent kill in 3 trials. Foliage injury was evident in all tests in alfalfa.

## E.P.N.

Two dosages of this poison were tested in 1952 on green alfalfa in Arizona. Applications were made in emulsion with the turbine blower. Two ounces gave an average kill of 61 percent and 6 ounces an average kill of 90 percent in 6 trials.

Residual Effectiveness of Sprays, 1951 and 1952

These experiments were designed to show under field conditions the residual effectiveness of various insecticides when applied as sprays.

The first part of these experiments was carried out on the San Carlos Indian Reservation in Arizona in 1951.

Aldrin, dieldrin, Compound 1189, and CS 708 (dilan) were included. Aldrin was applied at 2 and 3 ounces, dieldrin at 1 and 2 ounces, compound 1189 at 1½ pounds, and CS 708 at 1 pound per acre in solutions to 5-acre plots. The total of 6 treatments were duplicated, making a total of 12 plots. Populations on the plots varied from 5 to 10 per square yard on the grassy portions up to 100 per square yard in the patches of green alfilaria. The mixed infestation was predominently Aulocara elliotti, with fair numbers of M. mexicanus, Psoloessa texana pusilla, Hadrotettix trifasciatus, and a few M. cuneatus.

Spray applications were made on half of the plots on April 24 with the turbine blower and on the remainder April 25. On May 4, nine days after treatment, both plots receiving CS 708, one receiving compound 1189, and one receiving 2 ounces of aldrin were still partially infested. Since no sick or dying grasshoppers were observed these plots were abandoned. On all other plots the populations had been reduced to 2 or less per square yard.

On the 28th day, May 23, the plots receiving 3 ounces of aldrin and the remaining plots receiving 2 ounces of aldrin and compound 1189 were being reinfested. No change was noted in the plots receiving dieldrin except a decrease in the few hoppers remaining on one of the plots receiving 1 ounce of dieldrin.

On the 49th day one plot receiving 2 ounces of dieldrin, one receiving 1 ounce of dieldrin, one receiving 1½ pounds of compound 1189, and one receiving 3 ounces of aldrin were reinfested. Population counts on that date varied from 4 to 9 per square yard.

On the 62nd day after treatment, June 26, one plot receiving 2 ounces of dieldrin per acre had reduced the grasshopper population noted as 8.4 per square yard on June 13, to 1.2 per square yard. Dead and dying grasshoppers were noted on this plot. No freshly killed were noted on any of the other plots.

Under the conditions of this test CS 708 at 1 pound per acre gave no evidence of kill beyond 9 days. Compound 1189 at 1½ pounds per acre showed little evidence in 28 days and none in 49 days. Aldrin at 3 ounces gave some evidence of continued kill to 28 days. Dieldrin at 1 ounce gave some evidence of kill to 49 days. One plot treated with 2 ounces per acre was still killing hoppers in 62 days and between the 49th and 62nd days had reduced an infestation from 8.4 to 1.2.

The next phase of this work was carried out on Sheep Creek in Meagher County, Montana. On May 23, 1951, two 5-acre plots situated on a Camnula pellucida egg bed were sprayed; one with 3 ounces of aldrin in 1 gallon of diesel fuel per acre, and the other with 2 ounces of dieldrin in 1 gallon of diesel fuel. Hatching had started on both plots by the time the sprays were applied. The initial population was killed in the first 2 days by both treatments. Four days later (6 days after treatment) only first

instar hoppers were observed and many of these were affected. Nineteen days after treatment the plot receiving 3 ounces of aldrin was again infested to about the same level as before treatment.

Grasshoppers on the plot treated with dieldrin continued to hatch but were killed as rapidly as they emerged. Twenty-five days after treatment, on June 18, this plot was still free of grasshoppers, no further hatching was taking place, and the plot was abandoned.

Further tests of the residual effectiveness of aldrin and dieldrin were made in 1951 1952 on a ranch east of Melville, Montana, in Park County.

Three 5-acre plots and one 15-acre plot were sprayed as duplicate sets with 2 ounces of aldrin in 1 gallon of diesel fuel and with 1 ounce of dieldrin in 1 gallon of diesel. The three 5-acre plots were heavily infested with Camnula pellucida ranging from first to 4th instar. There was also a fair percentage of adult Aeropedellus clavatus and M. confusus. On the 15-acre plot the infestation was mixed, containing A. elliotti, A. clavatus, M. confusus, and a few C. pellucida.

Applications were made with turbine blower on June 2. One 5-acre plot and the 15-acre plot were treated with aldrin. The remaining 5-acre plots were treated with dieldrin. Initial kills on all plots were almost complete in 3 days. Hatching continued on all plots for several days but the nymphs were killed as quickly as they emerged. At the end of one week, June 9, one five-acre plot treated with dieldrin and the 15-acre plot were abandoned because there was little pressure from the outside and hatching was complete.

The remaining aldrin plot continued to be at least partially effective until the 18th day (June 20). On that date several second instar nymphs of Camnula were swept from the plot. This would indicate that a few newly emerged nymphs had survived. No freshly dead hoppers were seen.

The remaining dieldrin plot continued to kill newly emerged nymphs until the hatch was complete sometime around the 11th day after treatment. Pressure from outside the plot continued, however. Freshly dead and dying hoppers were picked up on the edge of the sprayed area on July 2. No reinfestation had taken place on that date.

Results of observations on Range Areas treated in 1950 and 1951.

Readings in 1952

| Area | Size Acres | Year Treated | Date | Insecticide | Hoppers per sq. yard | Hoppers per 100 Sweeps | | Percent early species | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Treated | Untreated | Treated | Untreated |
| Von Lenington | 8700 | 1950 | Late July | Aldrin | -1 | 16 | 104 | 33 | 26 |
| Von Lenington | 3063 | 1951 | July 17 | Aldrin | -1 | 11 | 104 | 45 | 26 |
| Lenington Bros. | 640 | 1951 | Aug. 11 | Dieldrin | -1 | 6 | 15 | 17 | 13 |
| Bud Lenington | 1000 | 1951 | July 26 | Aldrin | -1 | 7 | 24 | 71 | 33 |
| Diekahns | 1135 | 1951 | July 14 | Aldrin | -1 | 11 | 78 | 18 | 65 |
| Rowe | 860 | 1951 | July 26 | Aldrin | 1-2 | 77 | 283 | 60 | 55 |
| O'Hara | 1635 | 1951 | July 13 | Aldrin | -1 | 16 | 42 | 37 | 79 |
| Swan | 640 | 1951 | July 12-15 | Dieldrin & Heptachlor | -1 | 33 | 230 | 33 | 57 |

## Drift Spraying

The work on "drift" or strip spraying received its original impetus from a commercial job of strip spraying near Shonkin, Montana. Aldrin had been applied by airplane to alternate strips of range grass at 2 ounces per acre in the treated strips. This field was examined one week after treatment and showed a population which varied from nothing in the treated strips up to 24 per square yard in the untreated portion. The average for the entire field was 4 per square yard. No further reduction was noted in 30 days and the live hoppers were still concentrated on the untreated strips. These observations indicated that aldrin applied in strips at an overall dosage of 1 ounce per acre was unsatisfactory.

Dieldrin with its reputedly longer residual effectiveness was next considered as a possibility in this type of spray application. Two attempts were made in 1951 to evaluate strip spraying by aircraft, using dieldrin as the insecticide. The first application was made on 160 acres of range using a Bureau-owned Stearman. This plane was calibrated to apply 1 gallon of spray material per acre in 50 foot strips. For this experiment 1 ounce of dieldrin per gallon of spray was applied in 100 foot strips. All strips were laid across a light (up to 10 m.p.h.) north wind. In 3 days 85 percent of all the hoppers in the plot were killed. The kill in 7 days was reckoned at 99 percent. At no time were the alternate strips visible.

A second application was made by a commercial sprayer on a 640 acre plot. This plane was a Luscombe equipped with spinning brush applicators calibrated to deliver 1 gallon of spray per acre in 45 foot strips. In this test 1½ ounces of dieldrin was applied in 1 gallon of spray in 90 foot strips. Again the work was done in a light crosswind. The 48 hour kill was 70 percent. Live grasshoppers were noted only in the untreated portions. In 10 days these strips could still be identified although the total kill was 90 percent. In 14 days the kill was uniform at 96 percent.

These preliminary tests were followed by more elaborate ones in 1952 at Box Elder, Montana. All applications were made by a Bureau-owned N3N calibrated to deliver 1 gallon of spray per acre in 65 foot strips. Aldrin at 4 ounces per gallon and dieldrin at 1 and 1½ ounces were applied in 130-foot strips on 40-acre plots. Each test was replicated 4 times. The results are given in the tables below:

Drift Spraying Experiment, Box Elder, Mont. 1952

Replicates 1 and 2

| Plot No. | Treatment | Pre-treat. Pop. | Wind MPH | 3-day Pop. | 7-day Pop. | 14-day Pop. |
|---|---|---|---|---|---|---|
| 1 | Dieldrin ½ oz/A | 19 | 0-3 N | 9 | 2.4 | 0 |
| 2 | Aldrin 2 oz/A | 17 | 2.3-9.0 N | 2.8 | .40 | 0 |
| 3 | Dieldrin 3/4 oz/A | 19 | 2.3-4.5 N | 2.6 | .12 | 0 |
| 4 | Dieldrin ½ oz/A | 18 | 0-5.6 N | 2.2 | .60 | ) |
| 5 | Aldrin 2 oz/A | 17 | 1.7-6.8 E | 2.2 | .20 | 0 |
| 6 | Dieldrin 3/4 oz/A | 18 | 3.4-12.5 N | 2.0 | .40 | 0 |
| | | 18.0 | ~~1.6-6.9~~ Ave Vel 4.17 | 3.46 | .86 | 0 |

Replicates 3 and 4

| Plot No. | Treatment | Pre-treat. Pop. | Wind MPH | 3-day Pop. | 7-day Pop. | 14-day Pop. |
|---|---|---|---|---|---|---|
| 1 | Dieldrin ½ oz/A | 17 | 0-2.7 S | 3.0 | .60 | 0 |
| 2 | Aldrin 2 oz/A | 19 | 1-1.8 N | 4.2 | .20 | 0 |
| 3 | Dieldrin 3/4 oz/A | 16 | 0-1.0 E | 2.8 | .60 | 0 |
| 4 | Dieldrin ½ oz/A | 19 | 0-1.4 S | 6.0 | 1.80 | .20 |
| 5 | Aldrin 2 oz/A | 16 | 0-5.0 S | 6.0 | 2.00 | .60 |
| 6 | Dieldrin 3/4 oz/A | 16 | 0-2.8 S | 4.6 | .80 | 0 |
| | | 17. Ave Vel. 1.33 | | 4.42 | 1.0 | .135 |

One large scale test was conducted at Seligman, Arizona in August in conjunction with the control campaign on some 140,000 acres of range land.

Dieldrin at 1 and 1½ ounces per gallon was applied by a Bureau-owned DC-3 to two 1,280-acre plots. This plane was calibrated to deliver 1 gallon of spray per acre in strips 450 feet wide. The strips in this experiment were 900 feet wide. Wind velocities were estimated at 0 to 3 miles per hour.

Both plots showed 95 + percent overall reduction in hopper populations in 5 days. Live hoppers on both plots were confined to a few relatively narrow strips in dense Russian thistle. In at least two cases these strips were directly under the flight path of the aircraft.

All remaining live hoppers were retreated 5 to 6 days after the original treatment and the experiment was abandoned.

Another experiment was conducted at Fort Benton, Montana to evaluate strip applications in which all possible precautions were taken to avoid any spray deposit on untreated strips. The strips were laid out on range land with an infestation of 20 to 22 grasshoppers per square yard. Aldrin at 2 ounces per acre was applied to one set of strips and a duplicate arrangement was treated with dieldrin at 1/2 ounce per acre. Treated strips were all three rods wide. Three widths of alternate untreated strips were tested. These were 3 rods, 6 rods, and 9 rods. Results were evaluated at 2 day intervals until the 8th day and then at 5 day intervals until the 33rd day after treatment. By the 28th day random movements of grasshoppers from outside the treated area tended to obscure the results.

On all sprayed strips the grasshopper populations reached the lowest level in 13 to 23 days. On no sprayed strip was the population reduced to the low levels that we have learned to expect whenever plots or fields receive solid treatment. The lowest population observed on a sprayed strip was about 1 grasshopper per square yard. The grasshopper populations on all the untreated strips gradually diminished throughout the observation period. This reduction was greatest on the 3 rod strips and least on the 9 rod strips.

These observations support the conclusion that there was a definite gradual movement of grasshoppers from the untreated strips onto the treated ones. This movement was not rapid enough to bring any of the untreated strips down to the level of the treated areas. The populations on the 3 rod unsprayed areas were ultimately reduced to 3 to 5 grasshoppers per square yard. The average population on an area composed of alternately treated 3 rod strips would be about 4 per square yard. This is fair control and would show significant reduction in grasshopper damage but it would seem much better to spray the area solid at twice the cost and receive, in addition to better immediate control, considerable assurance that treatment of the same area would not be necessary the following year. Strip treatments in which the untreated strips are 6 rods wide or wider would not give acceptable results.

Any recommendations of drift spraying should be accompanied by a warning that failure to obtain proper drift may result in partial failures.